## Introduction

STM32F107xx connectivity line microcontrollers feature a complete 10/100 Ethernet MAC supporting MII and RMII with hardware support for the IEEE1588 precise time protocol, enabling Ethernet connectivity for real-time applications.

The objective of this application note is to introduce the different demos included in the LWIP TCP-IP package for the STM32F107_LK board.

- In the first part you will find information on the hardware and software required, and how to configure it.
- The second part explains how to run these demos.

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Note：

You will find additional information on LWIP package for STM32 in the Application note AN3102 available here :

http://www.st.com/stonline/products/literature/an/16620.pdf

You will find the link to the STM3210C-EVAL LWIP demo firmware here ：

http://www.st.com/stonline/products/support/micro/files/an3102.zip

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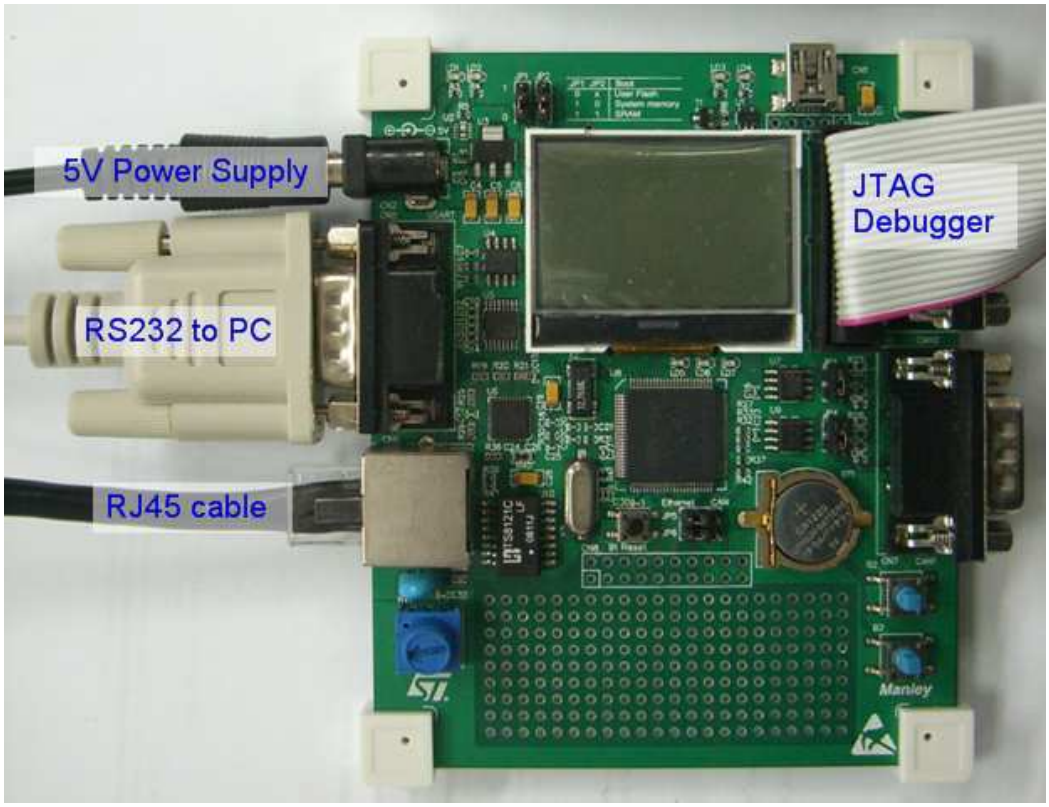
# 1 Introduction

This first chapter gives an introduction on how to use the different demos provided. It explains what are the hardware & software required, how to configure it. It also includes a simple description of the different demos' purpose and content .

## 1.1 What do you need

Here is the hardware required to run these demos :
- The STM32F107_LK Demo board (some demos require at least 2 boards)
- A JTAG debugger supported by IAR Workbench or RVMDK
- A 5V power supply
- An Ethernet cable to connect the board to your PC or to your Network

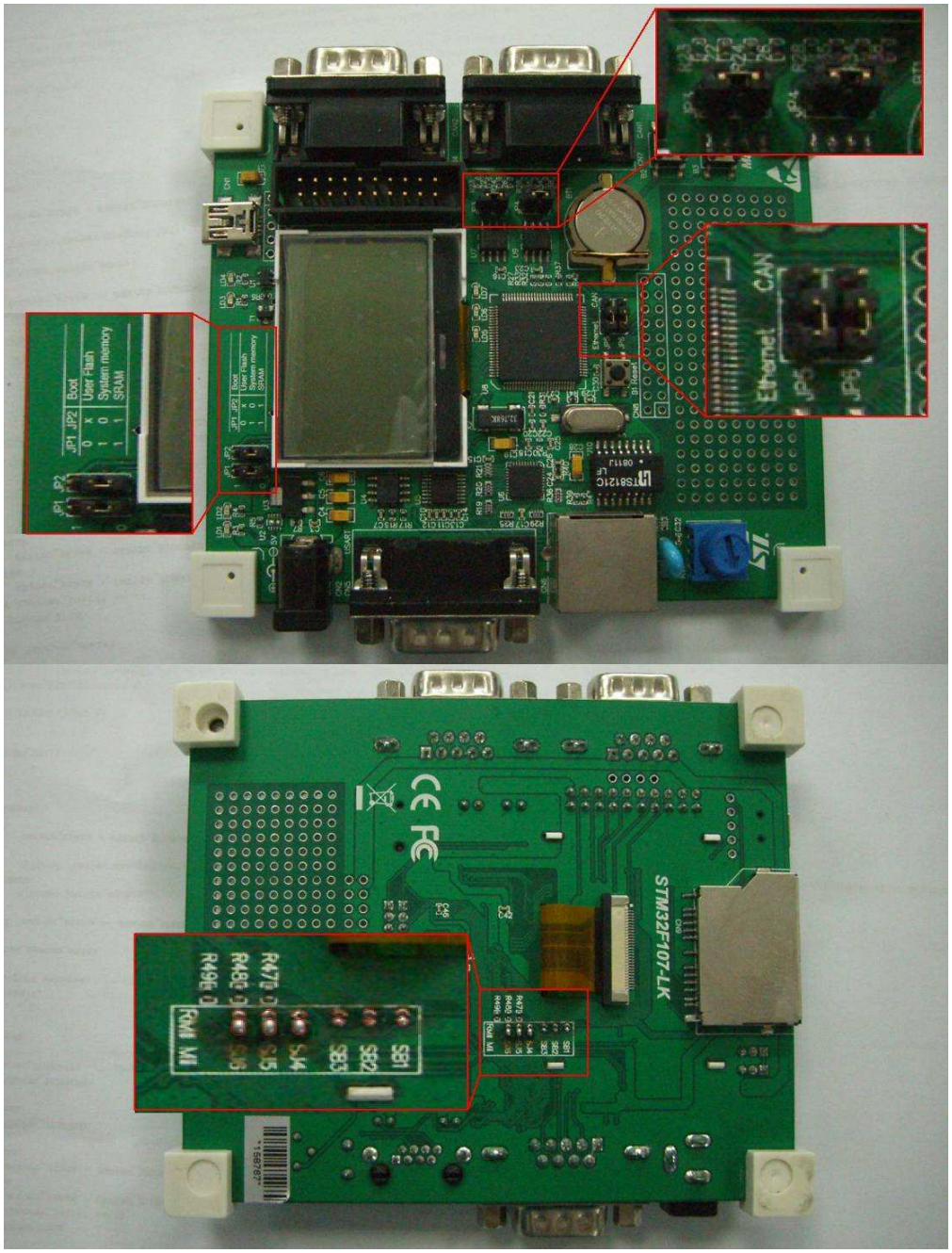



Note : the RS232 link to PC is not used in the current LwIP Package

Here are the softwares required
- IAR Workbench 5.x or RVMDK
- a TFTP Client (like tftpd32) available here : http://tftpd32.jounin.net/
- a Network analyzer (like WireShark) available here : http://www.wireshark.org/

## 1.2 How to configure the STM32F107 Learning Kit

Here is the required configuration of the demoboard :
JP1 & JP2 set to UserFlash position (0-X or jumper position 2-3)
JP3 & JP4 set
JP5 & JP6 set to Ethernet position (jumper position 2-3)
On the back of the demoboard, MII must be selected. To do so you need to solder the 3 “jumpers” on the lower right side.



## 1.3 Demo applications list

| Demo | Description |
|---|---|
| Simple Demo | The TCP-IP Stack without application modules |
| Telnet Demo | A simple helloword application using the Telnet protocol |
| UDP-TCP Client Demo | A set of 2 demos to be loaded on different boards:<br>- at least one client<br>- one server.<br><br>UDP & TCP Packets are exchanged between the 2 boards, to control some LED. |
| UDP-TCP Server Demo | |
| Web Server demo | A simple webpage hosted in the demoboard is displayed in your browser |
| TFTP Demo | A TFTP demo to get files from the demo board or put file into an SD card inserted in the board card reader |

## 1.4 Modules per Demo

The LWIP TCP-IP stack already contains many modules, not all the modules provided are used in each demos. The table below shows which modules are compiled (or not) in each example.

| Demo Name | EFSL (file system) | TCP – IP Key Modules | | | | | Application Modules | | | | Demos Application | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ARP | IP | ICMP | UDP | TCP | Ping | DHCP | DNS | TFTP Demo | Telnet Demo | WebServer Application | UDP-TCP Client | UDP-TCP Server |
| Simple Demo | ✘ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✘ | ✘ | ✘ | ✘ | ✘ | ✘ |
| Telnet Demo | ✘ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✘ | ✘ | ✓ | ✘ | ✘ | ✘ |
| UDP-TCP Client | ✘ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✘ | ✘ | ✘ | ✘ | ✓ | ✘ |
| UDP-TCP Server | ✘ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✘ | ✘ | ✘ | ✘ | ✘ | ✓ |
| Web server Demo | ✘ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✘ | ✘ | ✘ | ✓ | ✘ | ✘ |
| TFTP Demo | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✘ | ✓ | ✘ | ✘ | ✘ | ✘ |

# 2 Demos User Guide

The LWIP package for STM32F107xx connectivity line microcontrollers comes with a rich set of demos

**A simple application** implementing the LwIPTCP-IP stack, DHCP Client and PING application. once the STM32F107_LK board is connected to a DHCP server it gets its IP address and displays it on the LCD. the Ping application is available to check that the STM32F107_LK board is responding to ping requests.

**A simple Telnet demo** allow the PC to open a telnet connection with the board. This example is a simple “Helloword over telnet” kind of application

**UDP/TCP Client/Server:** this is a simple example based on a minimum of two STM32F107_LK Boards. One board is Server and all others are Clients. It provides source code examples for UDP and TCP connections.

**Webserver Demo** : it displays an html page once the STM32F107_LK board IP address (given by the DHCP) is typed in the web browser. This introduction page includes a presentation of the embedded protocols in LWIP. Another page shows a status bar displaying instantaneously the potentiometer (RV1) analog input conversion (available on STM32F107_LK board). The user can modify the potentiometer position and the status bar shape is updated accordingly. Another LED control page allows the user to turn ON/OFF the LEDs of the board.

**TFTP Server :** this lets the user PUT and GET files from the remote PC (client) to the STM32F107_LK board (Server). The files are read from (or written into) the SD Card inserted in the SD Card reader of the STM32F107 board.

## 2.1 Simple Application

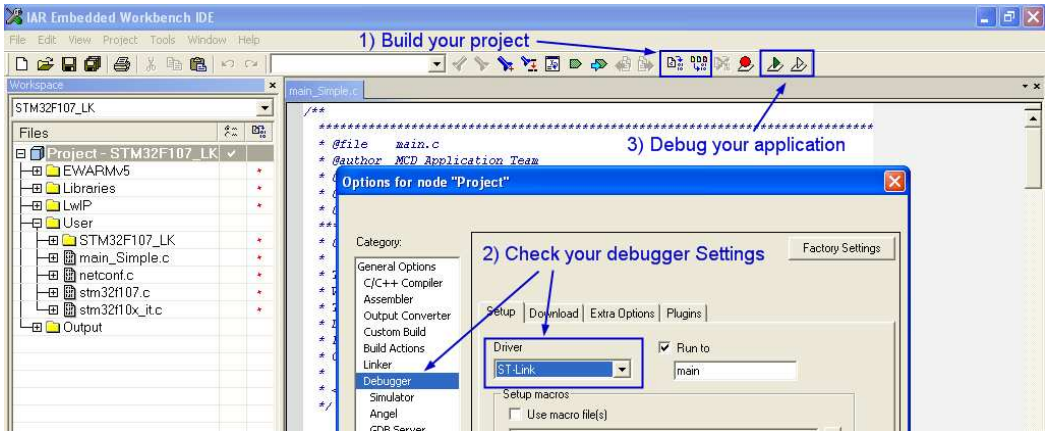
This simple example provides an application template, see below the procedure to run this example.

In this example, the board is connected on a network with a DHCP server, it automatically get this IP address. You may PING the board from your PC to check it is properly connected on the network.

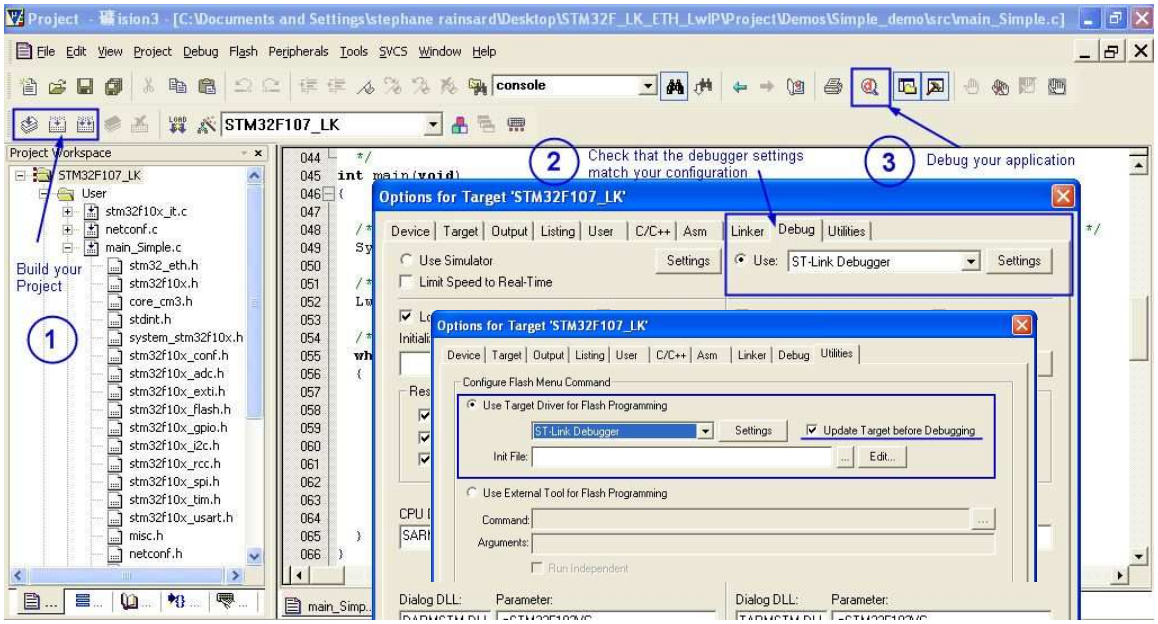
### 2.1.1 How to compile and download the demos

Once you opened the project with your IDE (IAR workbench or Keil ) follow the steps describes in the screen capture below to compile and run the demo.

**For IAR Workbench users :**




**For Keil RVMDK users**

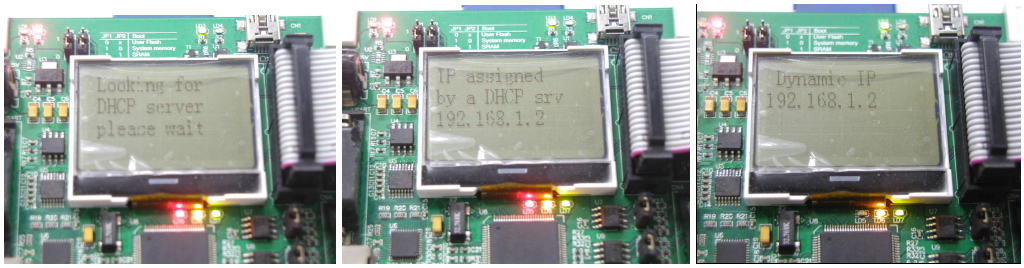


***Note :***
The IAR projects are build using IAR Embedded Workbench version 5.4. If these workspaces are opened with older version of IAR Embedded Workbench, an error message will be displayed and some of the project configuration will be lost.

One way to overcome this incompatibility is to get the newest version of IAR Embedded Workbench and open the project. Then you can use this new version of IAR, or recopy the project settings and complete the part of the configuration that was lost in your older IDE.

## 2.1.2 How to run the simple demo

When running this demo on a network with a DHCP server you should see the following :




Then you will be able to send a Ping command to the board.

```
Pinging 192.168.1.2 with 32 bytes of data:

Reply from 192.168.1.2: bytes=32 time<1ms TTL=255
Reply from 192.168.1.2: bytes=32 time<1ms TTL=255
Reply from 192.168.1.2: bytes=32 time<1ms TTL=255
Reply from 192.168.1.2: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

## 2.1.3 Using Wireshark to monitor the network traffic

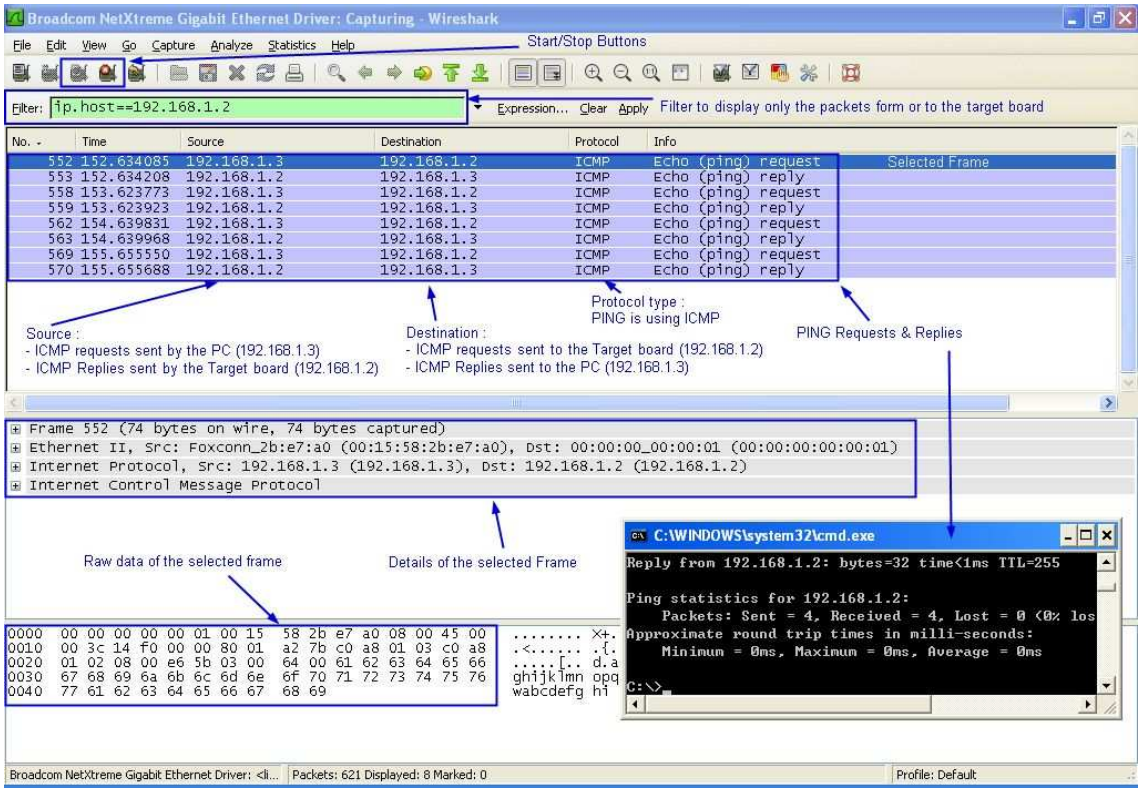
Wireshark Network analyzer is a freeware that allows you to see the packets exchanged between the PC and the Board.

To do so, you need to run Wireshark and in the menu Capture\Interfaces… select the network interface you want to log

Make sure to use the appropriate filter to display only the relevant part of the network traffic. Then you will get the following log.

In the Screen capture below you will find :

- an IP address filter : ip.host==192.168.1.2
- the packets sent or received by this IP address for a PING command
- The details of one frame


Broadcom NetXtreme Gigabit Ethernet Driver: Capturing - Wireshark
Start/Stop Buttons
Filter: ip.host==192.168.1.2
Filter to display only the packets form or to the target board
Selected Frame
Source :
- ICMP requests sent by the PC (192.168.1.3)
- ICMP Replies sent by the Target board (192.168.1.2)
Destination :
- ICMP requests sent to the Target board (192.168.1.2)
- ICMP Replies sent to the PC (192.168.1.3)
Protocol type :
PING is using ICMP
PING Requests & Replies
Raw data of the selected frame
Details of the selected Frame
C:\WINDOWS\system32\cmd.exe
Reply from 192.168.1.2: bytes=32 time<1ms TTL=255
Ping statistics for 192.168.1.2:
Packets: Sent = 4, Received = 4, Lost = 0 (0% los
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 0ms, Average = 0ms

*Note : Wireshark can only monitor the traffic sent or received by the PC, you won't be able to monitor the traffic between 2 boards.*

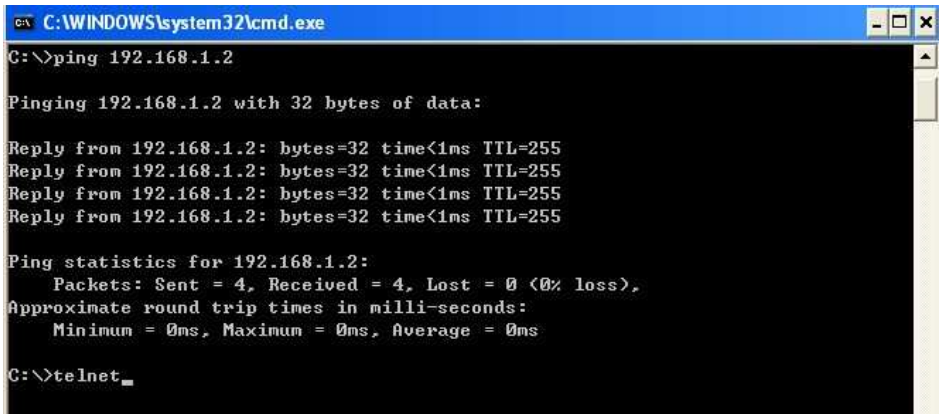
## 2.2 Telnet Application

(follow the procedure described in the Simple Application chapter on how to start the application.)

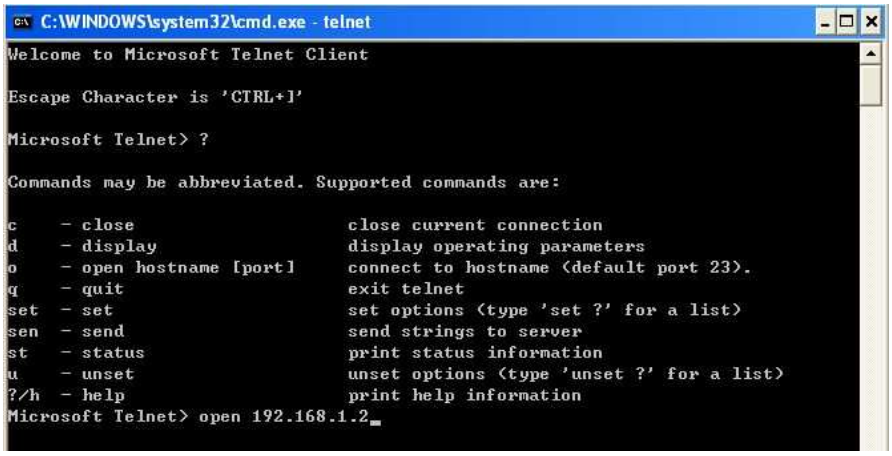
This demo implement a simple telnet application. Once the telnet connection is open between the PC and the Board, a simple “helloword” communication takes place.

To run this demo you need to open a telnet connections as follow :

1) You can first check the connection between your PC and the board using a PING command, once done you can run the Microsoft telnet client from the command line window using the command “telnet




2) Then you need to connect the client to the board, by using the command “open x.x.x.x” where “x.x.x.x” is the IP address of the board.




3) Then you should see the following “Helloword” communication :

## 2.3 UDP-TCP Client/Server demos

Theses demos implement a simple client/server communication protocol (data exchange, 1 byte data length). One server board and one or more client boards are required to run this example. Both can be directly connected with a crossover cable or plugged to a network with straight cables.

If a DHCP server is available, both boards get dynamic IP addresses. Once connected to the server, the board sends a TCP frame with 1 bytes of data on an opened connection asking to set/reset the LED1 when the Key B3 is pressed. If the Key B2 is pressed, the application sends a TCP frame with 1 bytes of data on an opened connection asking to set/reset the LED2.

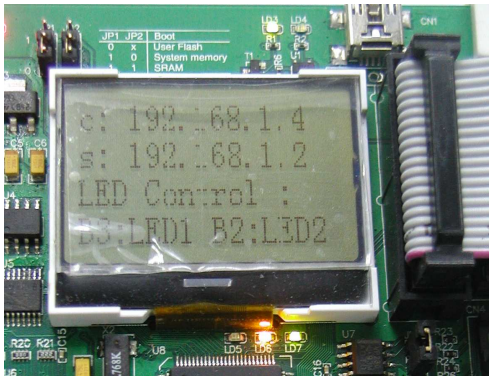
Depending on the byte value, it requests the Server application to set or reset the corresponding LED.

### 2.3.1 UDP-TCP Client Demo

(follow the procedure described in the Simple Application chapter on how to start the application.)

This demo requires having one other board configured as a server. Make sure that your starts the server board firsts, then the client board.

Once the 2 boards are connected you should see the following :




The c: x.x.x.x is the client IP address, in this example 192.168.1.4 is the board IP address

Once connected to the server, s: x.x.x.x will be displayed on the screen giving the server's IP address. In this example, 192.168.1.2 is the IP address of the remote server.

Once you see this screen you are able to control the server's LEDs using the 2 buttons of the board :

Here is the detailed communication flow between the client and server

**Part 1 : UDP Transfer**

- The server listen for UDP Data on a dedicated port (0x7 in this demo)
- The client broadcasts a UDP Packet on the network on the same port
- The server answers a UDP Packet to the client on a different port (0x4 in this demo)

Now both the client and the server know each other's IP address

**Part 2 : TCP Transfer**

- The server listen for TCP Data on a dedicated port (0x4 in this demo)
- Now that the client knows the server's IP address, it setup a TCP connection on this port
- Each time a is pressed, the client send a simple TCP packet to the server to turn on or off the LED

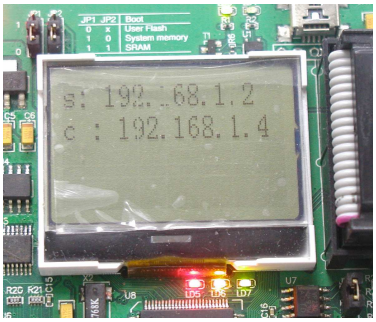
*NOTE : It is mandatory to first run the server board and then turn on the client board, otherwise the boards may not find each others.*

### 2.3.2 UDP-TCP Server Demo

(follow the procedure described in the Simple Application chapter on how to start the application.)

This demo requires to have at least one other board configured as a client. Make sure that your starts the server board firsts, then the client board.

Once connected you should see the following :




The s: x.x.x.x is the server IP address, in this example 192.168.1.2 is the board IP address

Once connected to the client, c: x.x.x.x will be displayed on the screen giving the client's IP address. In this example, 192.168.1.4 is the IP address of the remote client.

Once you see this screen the server's depending on the TCP packets received from the client.

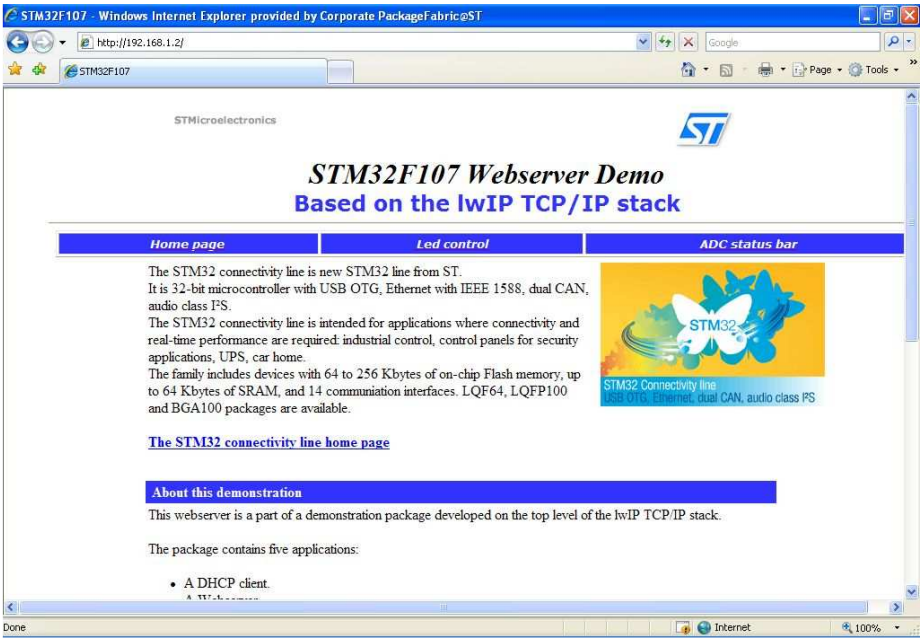
The workflow is the same as the one described in the client demo example.

## 2.4 Web Server Demo

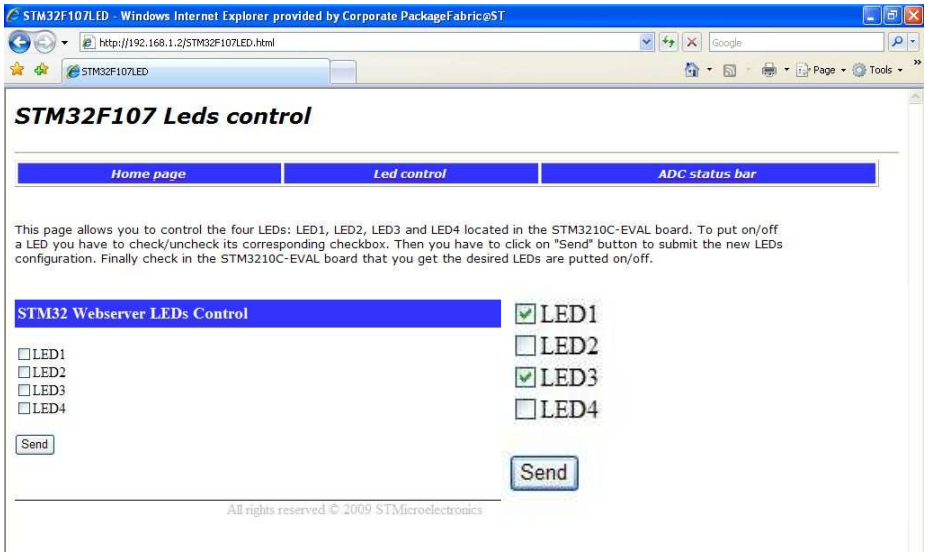
(follow the procedure described in the Simple Application chapter on how to start the application.)

In this demo, a simple webserver application is loaded into the board and accessed using your webbrowser.

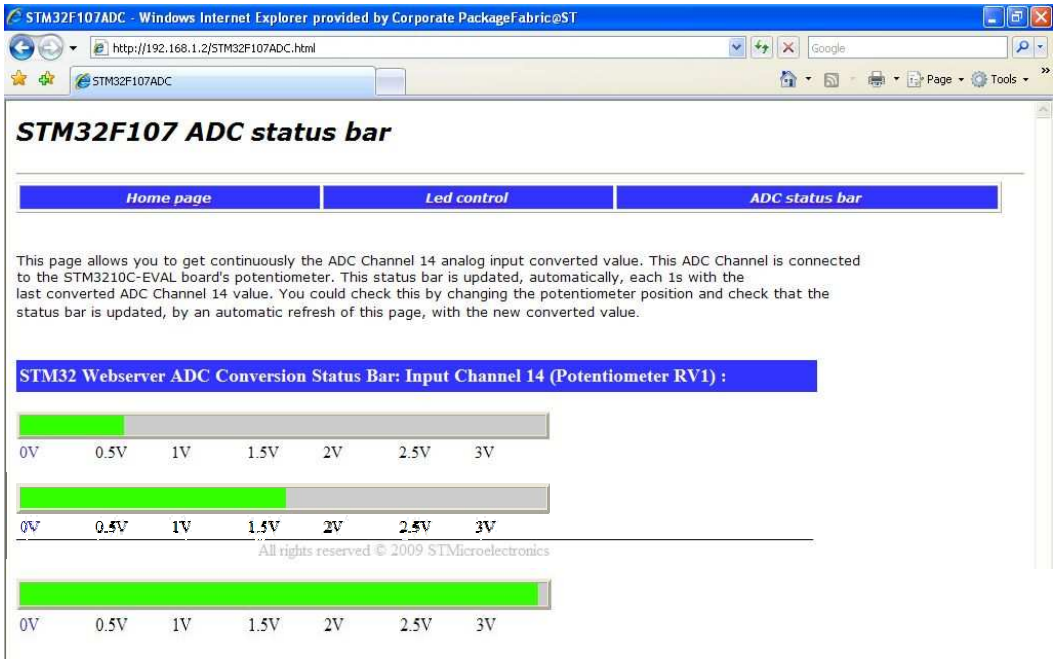
In this example, the board and the computer are connected on the same network, each of the devices getting its IP address from the DHCP server.


STM32F107 - Windows Internet Explorer provided by Corporate PackageFabric@ST
http://192.168.1.2/
STM32F107
STMicroelectronics
STM32F107 Webserver Demo
Based on the lwIP TCP/IP stack
Home page
Led control
ADC status bar
The STM32 connectivity line is new STM32 line from ST.
It is 32-bit microcontroller with USB OTG, Ethernet with IEEE 1588, dual CAN, audio class I²S.
The STM32 connectivity line is intended for applications where connectivity and real-time performance are required: industrial control, control panels for security applications, UPS, car home.
The family includes devices with 64 to 256 Kbytes of on-chip Flash memory, up to 64 Kbytes of SRAM, and 14 communiation interfaces. LQF64, LQFP100 and BGA100 packages are available.
STM32
STM32 Connectivity line
USB OTG, Ethernet, dual CAN, audio class I²S
The STM32 connectivity line home page
About this demonstration
This webserver is a part of a demonstration package developed on the top level of the lwIP TCP/IP stack.
The package contains five applications:
A DHCP client.
Done
Internet
100%

Clicking the led control link will bring you to a simple form allowing you to control the LED on the board. Please note that only 3 LEDs are available on the STM32F107_LK.


STM32F107LED - Windows Internet Explorer provided by Corporate PackageFabric@ST
http://192.168.1.2/STM32F107LED.html
STM32F107LED
STM32F107 Leds control
Home page
Led control
ADC status bar
This page allows you to control the four LEDs: LED1, LED2, LED3 and LED4 located in the STM3210C-EVAL board. To put on/off a LED you have to check/uncheck its corresponding checkbox. Then you have to click on "Send" button to submit the new LEDs configuration. Finally check in the STM3210C-EVAL board that you get the desired LEDs are putted on/off.
STM32 Webserver LEDs Control
LED1
LED2
LED3
LED4
Send
All rights reserved © 2009 STMicroelectronics

The ADC input displayed on the webpage is controlled by the potentiometer on the lower left corner of the STM32F107_LK demo board.


STM32F107ADC - Windows Internet Explorer provided by Corporate PackageFabric@ST
http://192.168.1.2/STM32F107ADC.html
STM32F107ADC
STM32F107 ADC status bar
Home page
Led control
ADC status bar
This page allows you to get continuously the ADC Channel 14 analog input converted value. This ADC Channel is connected to the STM3210C-EVAL board's potentiometer. This status bar is updated, automatically, each 1s with the last converted ADC Channel 14 value. You could check this by changing the potentiometer position and check that the status bar is updated, by an automatic refresh of this page, with the new converted value.
STM32 Webserver ADC Conversion Status Bar: Input Channel 14 (Potentiometer RV1) :
0V 0.5V 1V 1.5V 2V 2.5V 3V
All rights reserved © 2009 STMicroelectronics

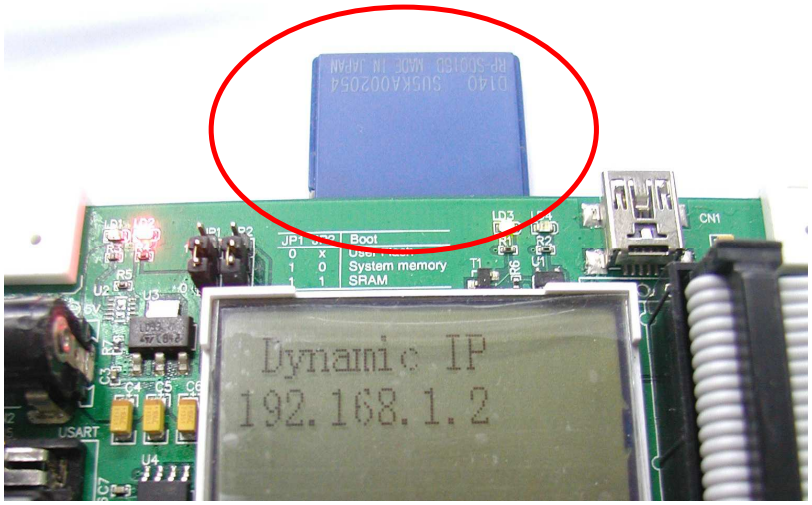
## 2.5 TFTP Demo

### 2.5.1 How to run the TFTP demo

Follow the procedure described in the Simple Application chapter on how to start the application, load the TFTP project in the STM32F107_LK board and run it.

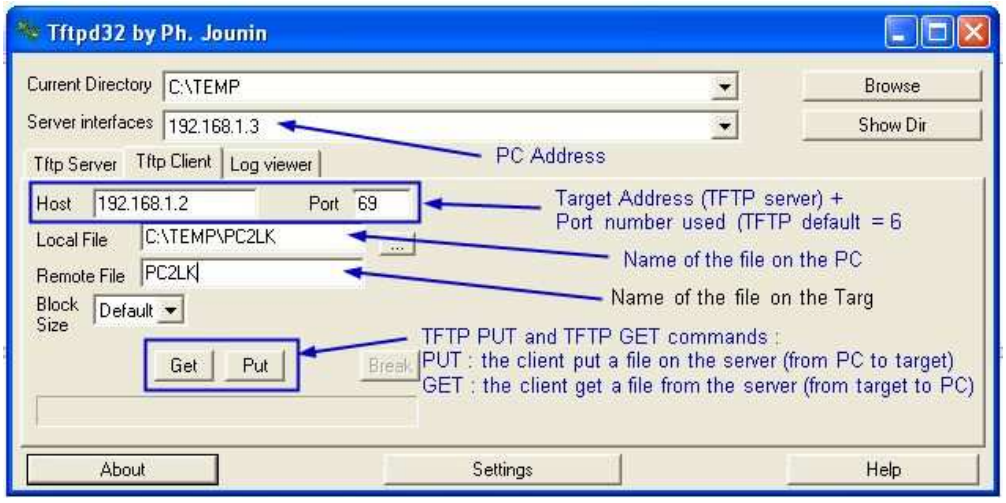
In this example, the server is the demo board and the PC is the client :
- the GET command of the Client (the PC) will request a file from the server and transfer it from the board to the PC
- the PUT command of the Client (the PC) will send a file to the server transfering it from the PC to the board

In this example, the files transferred from the PC to the board are stored in the SD card connected on the STM32F107_LK. So you need to make sure that a properly formatted SD Card is inserted into the card reader :

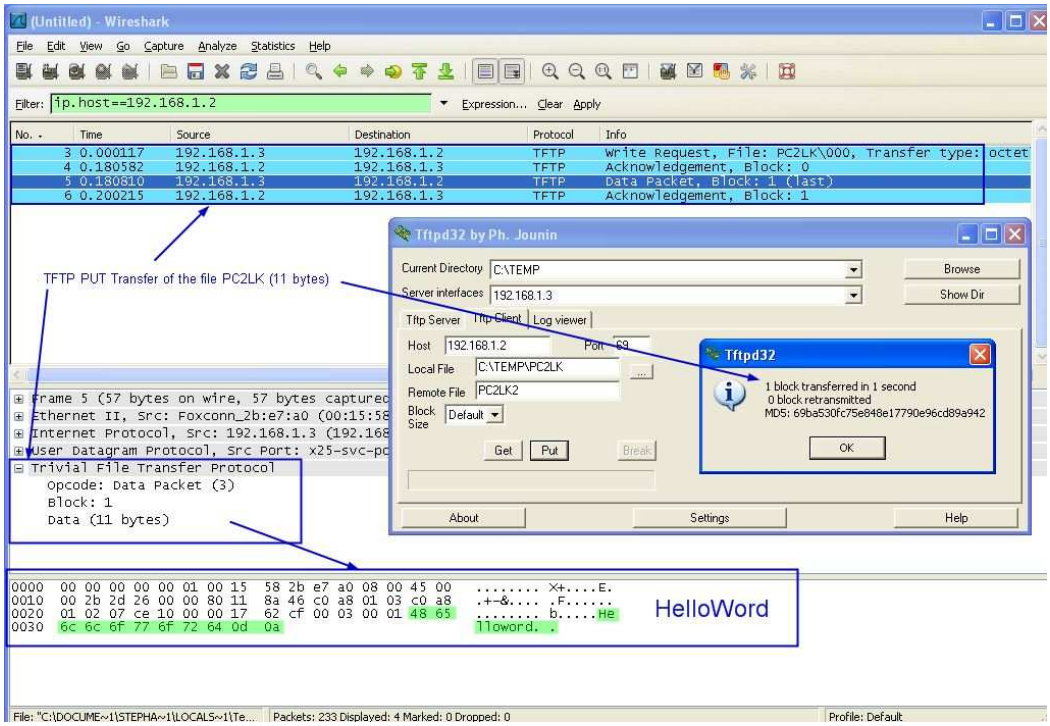



### 2.5.2 How to use tftpd32 and wireshark software

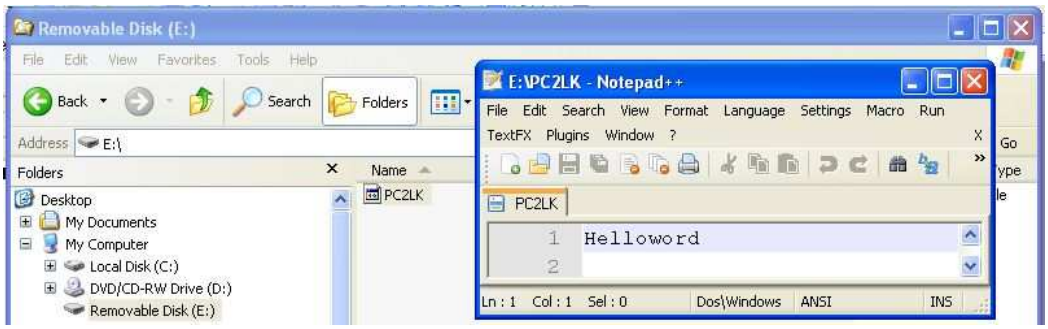
The following example, tftpd32 is used as a tftp client on the PC. Here is the interface



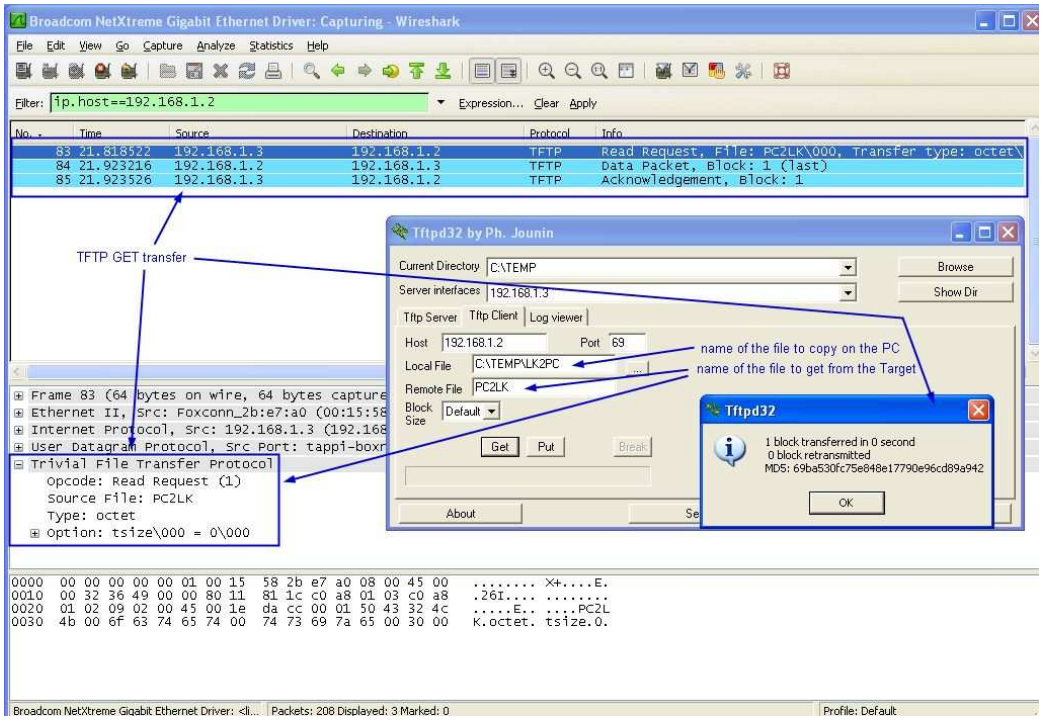
WireShark is also used to see the TFTP packets exchanged between the PC and the board. Here is a PUT Tranfer


(Untitled) - Wireshark
File Edit View Go Capture Analyze Statistics Help
Filter: ip.host==192.168.1.2
Expression... Clear Apply
No. Time Source Destination Protocol Info
3 0.000117 192.168.1.3 192.168.1.2 TFTP Write Request, File: PC2LK\000, Transfer type: octet
4 0.180582 192.168.1.2 192.168.1.3 TFTP Acknowledgement, Block: 0
5 0.180810 192.168.1.3 192.168.1.2 TFTP Data Packet, Block: 1 (last)
6 0.200215 192.168.1.2 192.168.1.3 TFTP Acknowledgement, Block: 1
TFTP PUT Transfer of the file PC2LK (11 bytes)
Tftpd32 by Ph. Jounin
Current Directory C:\TEMP
Server interfaces 192.168.1.3
Tftp Server Tftp Client Log viewer
Host 192.168.1.2 Port 69
Local File C:\TEMP\PC2LK
Remote File PC2LK2
Block Size Default
Get Put Break
Browse
Show Dir
About Settings Help
Tftpd32
1 block transferred in 1 second
0 block retransmitted
MD5: 69ba530fc75e848e17790e96cd89a942
OK
Frame 5 (57 bytes on wire, 57 bytes captured)
Ethernet II, Src: Foxconn_2b:e7:a0 (00:15:58
Internet Protocol, Src: 192.168.1.3 (192.168
User Datagram Protocol, Src Port: x25-svc-po
Trivial File Transfer Protocol
Opcode: Data Packet (3)
Block: 1
Data (11 bytes)
0000 00 00 00 00 00 01 00 15 58 2b e7 a0 08 00 45 00 ..... X+....E.
0010 00 2b 2d 26 00 00 80 11 8a 46 c0 a8 01 03 c0 a8 .+-&.... .F.....
0020 01 02 07 ce 10 00 00 17 62 cf 00 03 00 01 48 65 ..... b.....He
0030 6c 6c 6f 77 6f 72 64 0d 0a lloword. .
HelloWord
File: "C:\DOCUME~1\STEPHA~1\LOCALS~1\Te... Packets: 233 Displayed: 4 Marked: 0 Dropped: 0 Profile: Default

Once the PUT transfer is completed, you can see that the file PC2LK was copied in the SD card .



Now that there is one file into the SD Card, I can perform a GET operation to copy it back to the PC . Here is a GET transfer


Broadcom NetXtreme Gigabit Ethernet Driver: Capturing - Wireshark
File Edit View Go Capture Analyze Statistics Help
Filter: ip.host==192.168.1.2
Expression... Clear Apply
No. Time Source Destination Protocol Info
83 21.818522 192.168.1.3 192.168.1.2 TFTP Read Request, File: PC2LK\000, Transfer type: octet\
84 21.923216 192.168.1.2 192.168.1.3 TFTP Data Packet, Block: 1 (last)
85 21.923526 192.168.1.3 192.168.1.2 TFTP Acknowledgement, Block: 1
TFTP GET transfer
Frame 83 (64 bytes on wire, 64 bytes capture
Ethernet II, Src: Foxconn_2b:e7:a0 (00:15:58
Internet Protocol, Src: 192.168.1.3 (192.168
User Datagram Protocol, Src Port: tappi-boxr
Trivial File Transfer Protocol
Opcode: Read Request (1)
Source File: PC2LK
Type: octet
Option: tsize\000 = 0\000
Tftpd32 by Ph. Jounin
Current Directory C:\TEMP
Server interfaces 192.168.1.3
Browse
Show Dir
Tftp Server Tftp Client Log viewer
Host 192.168.1.2 Port 69
Local File C:\TEMP\LK2PC
Remote File PC2LK
Block Size Default
Get Put Break
About
name of the file to copy on the PC
name of the file to get from the Target
Tftpd32
1 block transferred in 0 second
0 block retransmitted
MD5: 69ba530fc75e848e17790e96cd89a942
OK
0000 00 00 00 00 00 01 00 15 58 2b e7 a0 08 00 45 00 ........ X+....E.
0010 00 32 36 49 00 00 80 11 81 1c c0 a8 01 03 c0 a8 .26I.... ........
0020 01 02 09 02 00 45 00 1e da cc 00 01 50 43 32 4c .....E.. ....PC2L
0030 4b 00 6f 63 74 65 74 00 74 73 69 7a 65 00 30 00 K.octet. tsize.0.
Broadcom NetXtreme Gigabit Ethernet Driver: <li...
Packets: 208 Displayed: 3 Marked: 0
Profile: Default